

Remarks: Examination Report

1. Claims 1-33 and 35-39 are pending.
2. Claims 1-7, 9-33, and 35-39 were rejected under 35 U.S.C. 103(a) as being unpatentable over Agee (U.S. 6,128,276) in view of Wallmeier (U.S. 6,553,033).
3. Claim 8 was rejected under 35 U.S.C. 103(a) as being unpatentable over Agee (U.S. 6,128,276) in view of Wallmeier (U.S. 6,553,033) and further in view of Raleigh (U.S. 5,809,422).
4. With regard to Claims 1-7, 9-33, and 35-39, the Examiner states that although Agee does not specifically disclose providing for multi-stage combining of the weighted spectral components (such as recited in the Independent Claims 1, 20, 31, and 35), Wallmeier teaches providing for multi-stage combining of the weighted spectral components.
5. Applicant submits that the above-recited step of providing for multi-stage combining of the weighted spectral components to cancel co-channel interference in the Independent Claim 1 (and hence in the dependent claims 2-19), the step of providing for multi-stage demultiplexing of the interfering signals by processing either or both the amplitude variations and the phase variations of the plurality of spectral components in a multi-stage demultiplexer recited in Independent Claims 20 and 31 (and hence in the dependent claims 21-30 and 32-34), and the above-recited multistage spatial demultiplexer in Independent Claim 35 (and hence in the dependent claims 36-39) present novel methods and structure that the cited combination of prior-art references neither describe nor anticipate. Furthermore, the above-recited novel structure and methods provide a substantial improvement in the performance of spatial demultiplexers that employ spectral decomposition, and therefore should be considered non-obvious, making the claims patentable under 35 U.S.C. 103.

6. Specifically, by providing for multi-stage combining/demultiplexing of interfering spectral components, substantially enhanced signal separation is achieved as a measure of signal quality. Multi-stage combining for interference cancellation is known to provide superior performance compared to single-stage combining. However, multi-stage combining of spectral components is a novel approach. This is because multi-stage combining requires that the individual spectral components have *different* amplitudes, whereas prior-art spreading typically involves providing each data symbol with the *same* amplitude-versus-frequency profile and channel compensation performed by a receiver equalizes received spectral components prior to combining/demultiplexing. Thus, multi-stage combining is enabled by the present invention because it employs data symbols provided with unique amplitude-versus-frequency profiles, which are impressed by the transmitter and/or result from flat fading in a plurality of unique multipath environments.
7. **None of the prior-art references teach to employ a multi-stage combiner/demultiplexer for separating signals impressed on a plurality of spectral components.**

Wallmeier (U.S. 6,553,033) relates to a process of transmitting ATM cells, and in particular, employing priority weights to control and schedule transmissions for multiple information streams. These priority weights are substantially different from the spectral weights described in Applicant's invention. Similarly, **the demultiplexer shown in Wallmeier does not pertain to spectral components nor is it capable of separating interfering signals.** The weights described in Wallmeier are **logical weights** (which convey priority) for controlling transmission rates. These logical weights are data bits that are typically inserted in the header of an ATM cell and extracted by a system, which then performs an assigned control operation on the data. Logical weights are distinct from **physical weights**, which are complex values that multiply signal values (such as spectral components) prior to demodulation into data bits.

These weights control the maximum rate at which each ATM cell stream is transmitted (col. 1, lines 31-48). The problem cited relative to the prior art is that such scheduling processes are unable to limit the peak transmission rate seen by connection elements downstream from the scheduling process. Consequently, when the peak transmission rate is exceeded, ATM cells are discarded to avoid overloading (col. 1, lines 49-56).

Wallmeier describes a method for matching the peak ATM cell rates to the transmission capacity of each downstream connection element. To achieve this goal, multiple scheduling devices incorporating buffer memories are employed between multiplexers and demultiplexers. The nature of ATM provides for sequential transmission of ATM cells across a communication interface. Accordingly, **multiplexing occurs in the time domain rather than the frequency domain**. For example, multiple cell streams are combined into a single stream of interleaved cells. Therefore, **multiplexing techniques disclosed in Wallmeier do not include overlapping, or otherwise interfering, data channels**.

Agee shows and describes only a single-stage demultiplexer.

All other prior-art techniques that separate interfering signals impressed onto a plurality of spectral components disclose only single-stage demultiplexers. For example, prior-art systems that spread data across multiple spectral components (or carriers) typically provide for substantially uniform spreading, which makes multi-stage combining/demultiplexing impractical. Single-stage techniques, such as maximal ratio combining, equal gain combining, and minimum mean squared error combining are performed. For example, in B. Natarajan, C. Nassar, S. Shattil, M. Michelini, and Z. Wu, "High-Performance MC-CDMA via Carrier Interferometry Codes," IEEE Trans. Veh. Tech., Sept. 1999, both MC-CDMA and Carrier Interferometry codes spread data symbols uniformly across subcarriers (spectral components) which are combined in a receiver using minimum mean squared error combining to separate the spectrally overlapping (and thus, interfering) signals.

8. The Novel Physical Feature of the Claims Provide New and Unexpected Results and Hence Should Be Considered Non-obvious, Making the Claims Patentable Under 35 U.S.C. 103.

9. Applicant submits that the above-recited novel features in the independent claims, and hence in all claims, provide new and unexpected results and therefore should be considered non-obvious, making the claims patentable under 35 U.S.C. 103.

10. Specifically, by providing for multi-stage combining of weighted spectral components to cancel co-channel interference, a substantially higher degree of spectral interference cancellation can be achieved compared to all other prior-art interference-cancellation techniques. Computer simulations conducted by Applicant demonstrate at least a 3dB performance improvement. When considering cellular and peer-to-peer network architectures that exploit spatial division multiple access, a 3dB performance improvement can translate into order-of-magnitude improvements in throughput and system capacity.

11. None of the prior-art references teach to perform multi-stage combining of weighted spectral components to cancel co-channel interference

Wallmeier shows a multi-stage system for demultiplexing ATM data streams interleaved in time rather than demultiplexing signals modulated onto different spectral components. The Wallmeier system and technique processes logical weights incorporated into packet headers to control transmission rates, rather than spectral weights in response to channel fading. The multiplexing techniques disclosed in Wallmeier do not include processing overlapping, or otherwise interfering, data channels.

Agee fails to show or describe a multi-stage combiner or demultiplexer.

Additional Reasons Militate in Favor of Non-obviousness

12. In addition to the above new and unexpected results, Applicant submits that additional reasons militate in favor of patentability, as follows:
13. **The combination of Wallmeier and Agee is non-obvious because Wallmeier and Agee pertain to distinctly different arts.** Wallmeier describes an ATM protocol, which employs high-rate data packets multiplexed in time, whereas Agee describes a multicarrier protocol in which data transmissions are multiplexed in time. Furthermore, Wallmeier pertains to a MAC-layer protocol for separating data symbols interleaved in time, whereas Agee pertains to a Physical-layer protocol of separating interfering signals prior to demodulation into data symbols. Therefore, a person of ordinary skill in the art of Physical-layer signal processing would not convert the MAC-layer protocol disclosed in Wallmeier into a Physical-layer processing technique.
14. **The prior art fails to teach how a combination of Wallmeier and Agee can be provided.** Since Wallmeier teaches to separate non-interfering data symbols interleaved in time and Agee teaches to separate interfering signals that overlap in frequency, the Wallmeier and Agee approaches are incompatible with each other. The prior fails to teach how the compatibility issues can be overcome to enable such a combination. Therefore, a person of ordinary skill in the art of Physical-layer signal processing would not be able to convert the MAC-layer protocol disclosed in Wallmeier into a Physical-layer processing technique.
15. **The prior art fails to suggest any utility in combining Wallmeier and Agee.** Although different to the present invention, such protocols have use, as is evidenced by the teaching of the prior art. Such use is served by the Wallmeier protocol, and there is no teaching in the prior art to change this MAC-layer protocol so as to resemble or reflect the Physical-Layer protocol of the present invention. As there is **no motivation to change, no teaching to change, and no description of how any change may be made** to produce a multi-stage demultiplexer to separate interfering signals impressed on a plurality of spectral components, it is submitted that the

presently claimed invention is also non-obvious, making the claims patentable under U.S.C. 103.

16. **The Claimed Invention contradicts the teachings of the prior art.** In particular, the prior art teaches to equalize the spectral components prior to combining in order to compensate for flat fading due to multipath effects. However, such equalization prevents the realization of performance benefits that can be achieved by multi-stage combining.

The Cited but Non-Applied References

17. These subsidiary references have been studied, but are submitted to be less relevant than the relied-upon references.